TRAINING APPLIANCES FOR MARKSMEN

Filed March 21, 1960 6 Sheets-Sheet 1

FIG. 1

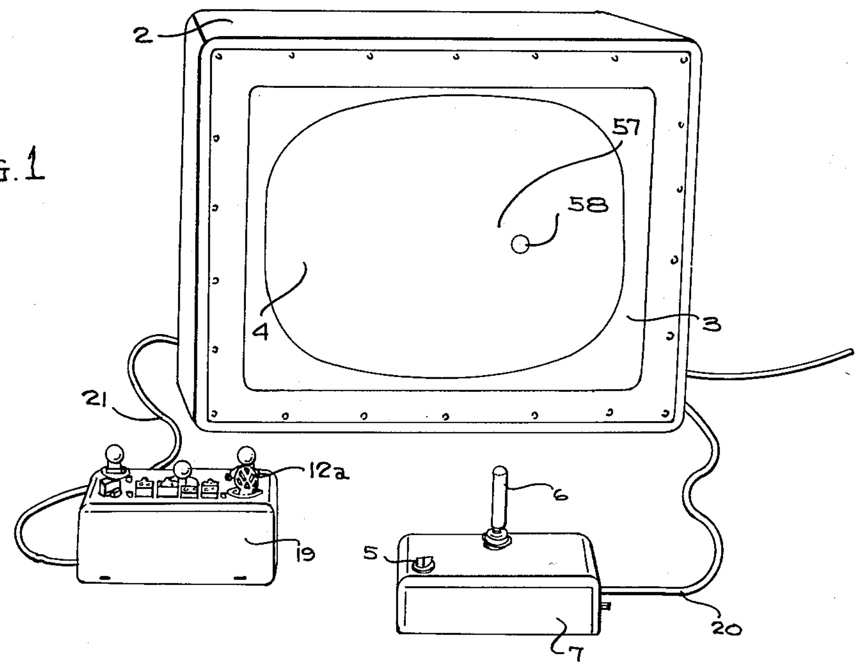
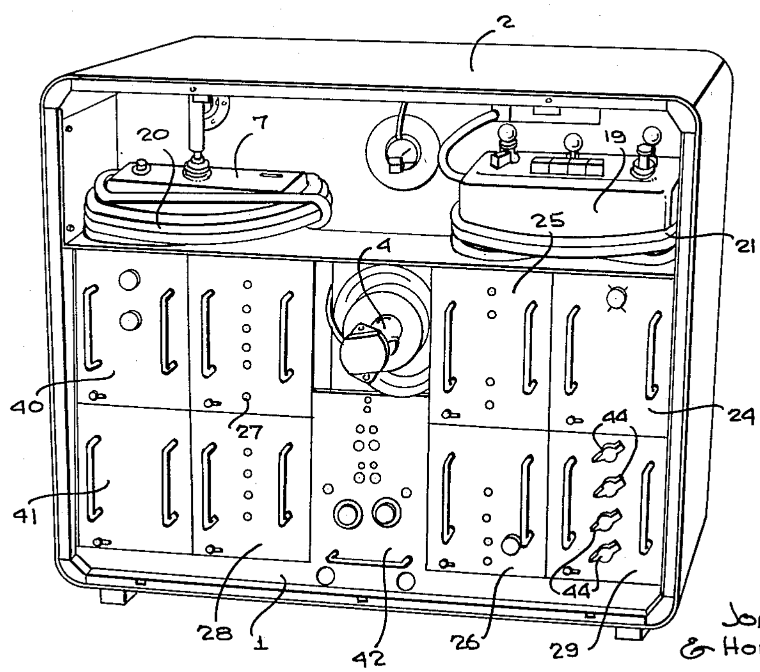


FIG. 2



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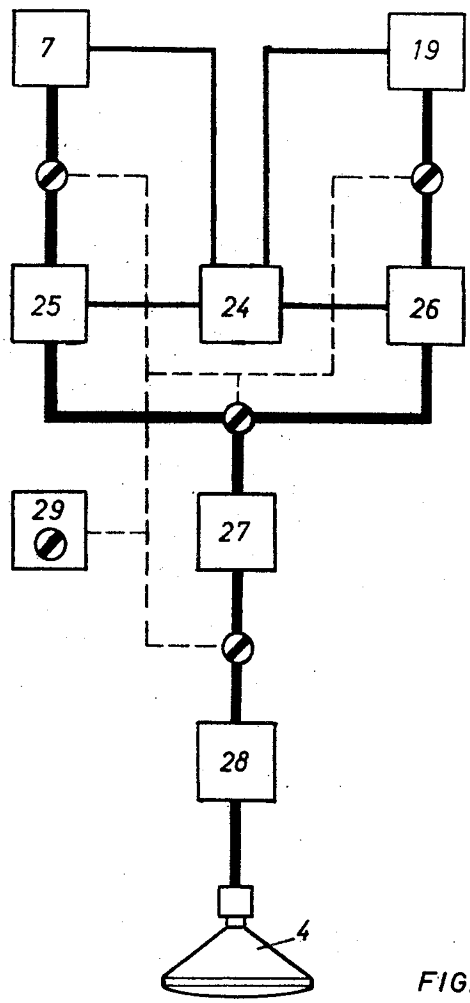

FIG. 3

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TRAINING APPLIANCES FOR MARKSMEN

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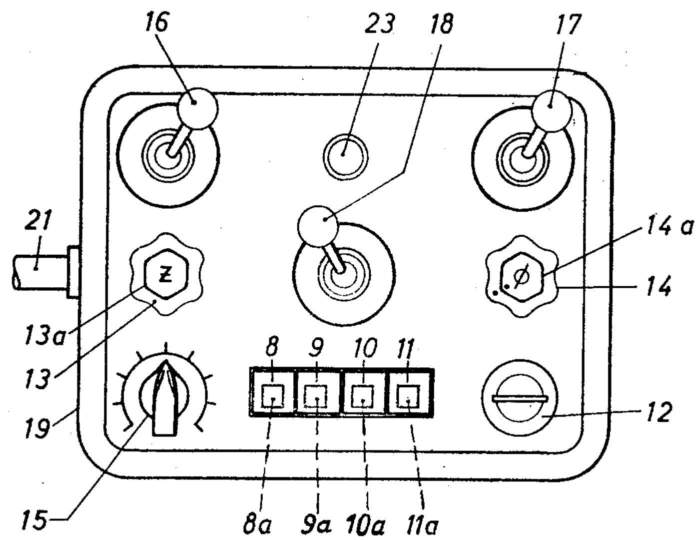

FIG. 4

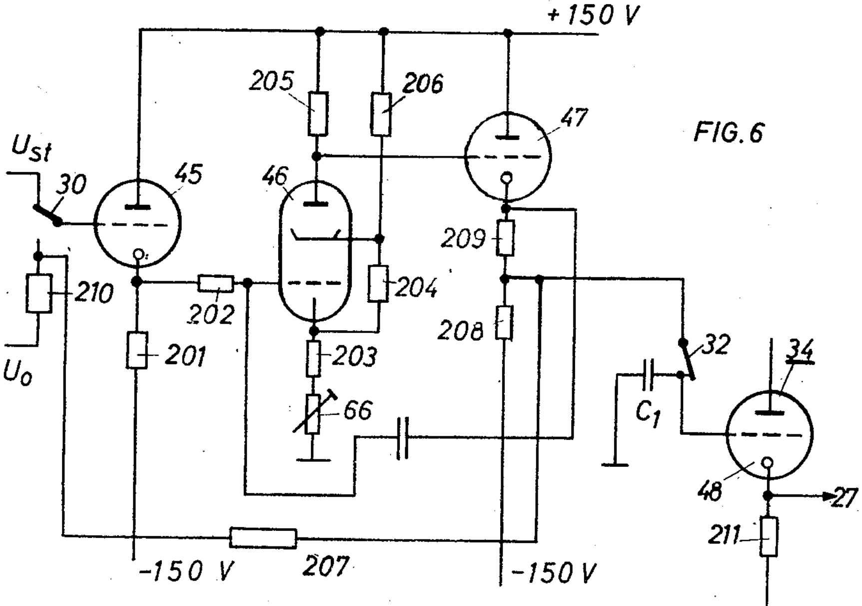

FIG. 6

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July 31, 1962 J. HERMANN ETAL 3,046,676

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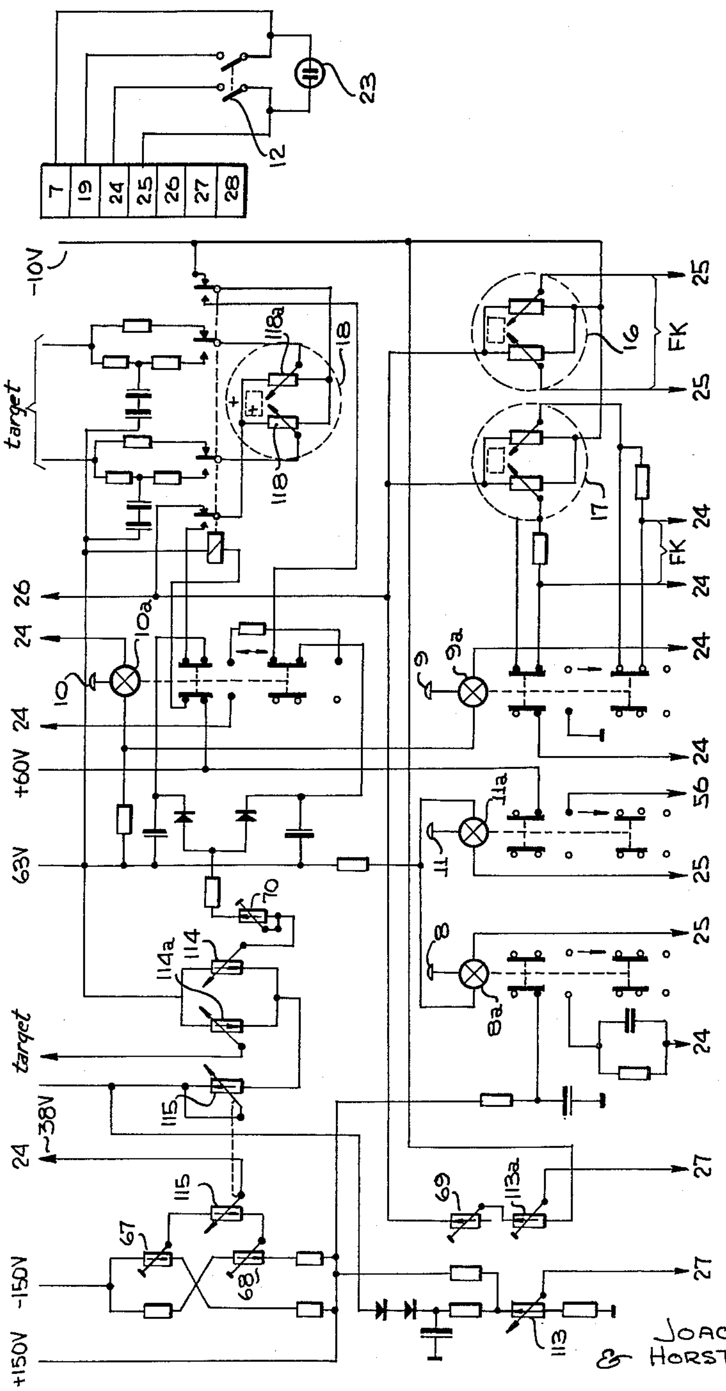
FIG. 5



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TRAINING APPLIANCES FOR MARKSMEN

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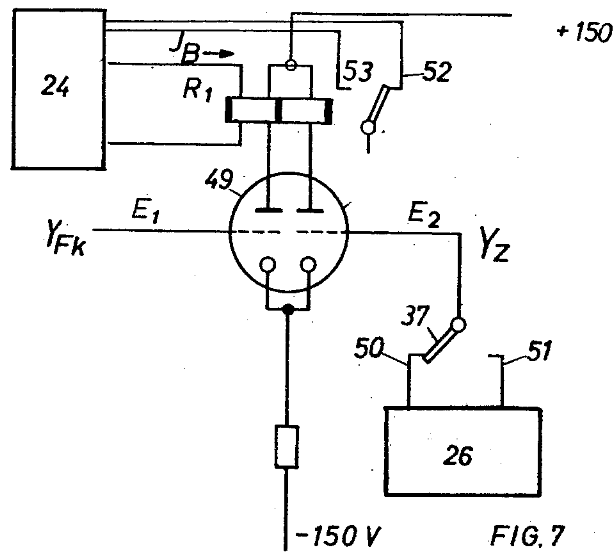

FIG. 7

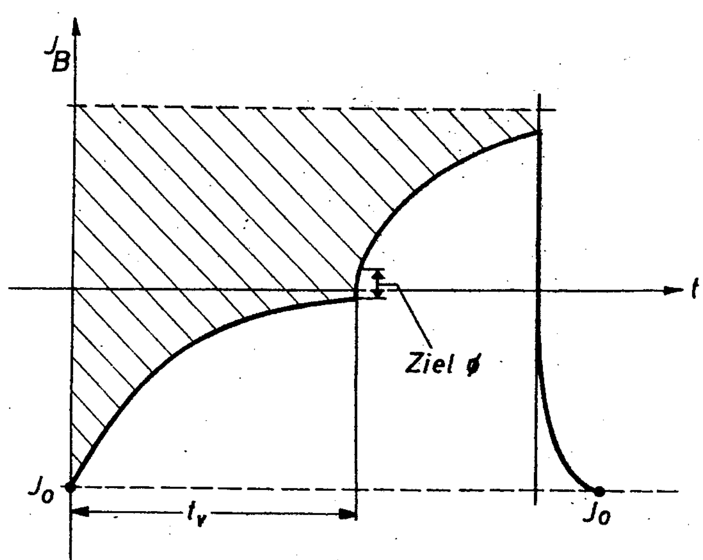

FIG. 9

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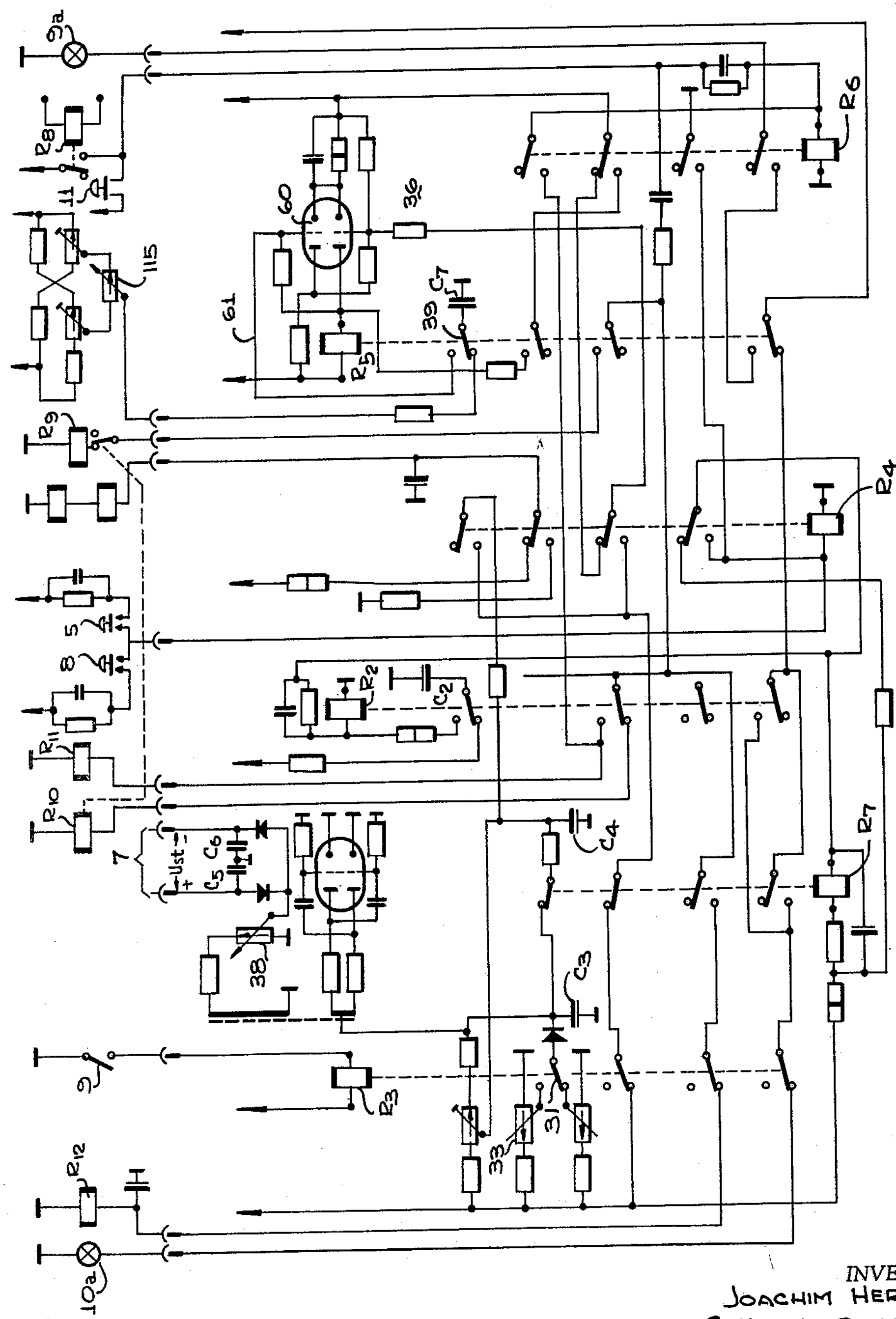

FIG. 8

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United States Patent Office

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TRAINING APPLIANCES FOR MARKSMEN

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Claims priority, application Germany Mar. 26, 1959
21 Claims. (Cl. 35—25)

The invention relates to a simulating device in the form of a practice device for training marksmen to steer guided missiles onto a stationary or mobile target. Such missiles are normally steered onto a target, according to the known line-of-sight method, by a marksman who stays at or near the firing point, by means of a steering device which has a control element, for example in the form of a control column. Thus, the marksman's task is to bring the missile during its flight into alignment with the target by suitably adjusting the control element, and to keep it in alignment until the missile has reached its target. Long training periods for the marksmen and constant practice are essential in order to achieve high scores. However, practice shoots with guided missiles are very expensive because the guided missiles are destroyed in the process. For this reason, practice devices or so-called simulators have been developed which simulate the properties of the guided missile and its reactions to deflections of a control surface thereof.

However, known simulators have certain disadvantages. They are expensive and take up excessive space. Also, known simulators simulate the movements of the missile but not the possible movements of the target. As practice devices for representing a mobile target there are so-called "shooting movies" in which a film of a mobile target is projected onto a canvas screen and a light speck which represents the movements of the missile is likewise projected onto the screen by an electronic computer which simulates the missile. These "shooting movies" have the disadvantage that the marksman becomes familiar with the movements of the target after very few practice runs and thus the result of the training becomes misleading.

The invention accordingly resides in providing a portable device in which the movements of the missile and target are simulated in the form of two light specks on the screen of a cathode ray tube, the movements of the two specks being controllable. Further, the invention provides a device of the kind in question, in which the ground can be simulated so as to avoid both flight underneath the target, which has been possible with known simulators, and realignment of the missile with the target after the missile has flown over the target. The invention further resides in a steering device for the trainee and an operating device for the instructor, both in the form of compact boxes, which can be set up in front of the screen of the cathode ray tube. The steering device should comprise a start button for releasing the simulated missile flight and adjusting means in the form of a control column for guiding the missile. The operating device should comprise adjusting means for steering the target and setting its speed, size and distance. The operating device should also have adjusting means for setting the apparent firing point of the missile and its direction of firing. Still further, the operating device is to have switch means permitting the setting of various stages for a course of training.

It is proposed to keep the entire appliance to about the size of a conventional table-model TV set so that it may be readily portable.

Other aspects and features of the invention will appear from the following description with reference to the accompanying drawings representing a preferred example of the invention. The illustrated embodiment only serves

to explain the invention without restricting the scope of the invention as defined in the appended claims.

In the drawings:

FIG. 1 is a perspective view of the simulator in the operating condition,

FIG. 2 is a perspective rear view of the simulator in its portable condition, the back cover being removed,

FIG. 3 is the block diagram of the simulator,

FIG. 4 is a plan of the operating device of the simulator,

FIG. 5 is the circuit diagram of the operating device,

FIG. 6 is the simplified circuit diagram of an amplifier, one of which is used for simulating the missile and another for simulating the target,

FIG. 7 is the circuit diagram of a differentiating amplifier for simulating sloping ground,

FIG. 8 is the simplified circuit diagram of the program unit of the simulator, and

FIG. 9 is a graph of the auxiliary current supplied to the differentiating amplifier of FIG. 7, plotted against time t.

The structural elements of the illustrated simulator device, which are in the form of rack units, are accommodated in a housing **2** surrounding a frame **1** (FIG. 2). The front of the housing is covered by a glass pane **3** (FIG. 1) behind which there is arranged a single-beam cathode ray tube **4**. As described in greater detail hereinafter, a light speck **57** simulating the missile and one **58** simulating the target are produced on the screen of this tube.

A steering device **7** for the trainee, comprising a start button **5** and a control column **6**, and an operating device **19** (FIG. 4) comprising operating keys **8**, **9**, **10**, **11**, a main switch **12**, adjusting knobs **13**, **13**a, **14**, **14**a, and **15** and adjusting means **16**, **17**, **18** in the form of control columns are, when in the operating condition, electrically connected to the simulator by lines **20** and **21**, respectively, as shown in FIG. 1.

The members **5**, **6** and **8** to **18** could be located direct on the housing **2** of the simulator. However, the illustrated arrangement is particularly suitable for steering practice because the trainee cannot watch the adjustments being made at the operating device **19**.

Rack units **24** to **29** and **40** to **42**, each containing an operating group, are arranged within the frame **1** as shown in FIG. 2. The units **40** and **41** serve as power supplies for the device and contain the usual transformers, stabilisers, etc. The unit **42** substantially conforms to conventional means for controlling a cathode ray tube such as is used with oscillographs. The upper portion of the frame **1** is provided with a shelf **43** for accessories extending over the entire width of the frame for receiving the steering device **7**, the operating device **19**, as well as their associated cables, and a main connecting line when the device is inoperative. The steering device **7** and operating device **19** can each be fixed to the frame **1** by locking means (not shown). The back of the housing **2** can be closed by a rear panel (not shown) having a pivoted flap for releasably closing the accessory shelf **43**.

In the steering device **7**, control voltages are adjusted by means of the control column **6** and fed to the rack unit **25** over the line **20**. By means of the start button **5** the light speck **57** simulating the missile can be released on the screen of the cathode ray tube **4** in a manner determined by the operating device **19**, namely, at a starting point as set by the adjusting means **16** and in an initial direction as set by the means **17**.

The instructor can set all the functions of the simulator at the operating device **19** (FIG. 4). The main switch **12** (also see FIG. 5) can be locked by a safety key, so that unauthorised persons cannot operate the simulator. Brightness controls **113** and **113**a (FIG. 5) for the light

specks **57**, **58** simulating the missile and target, respectively, can be actuated by means of the adjusting knobs **13**, **13***a*. The controls **113**, **113***a* act through a switch unit contained in the rack unit **27** and separately influence the electron beam tracing the missile and target.

The adjusting knob **15** serves to regulate the target distance. Its scale extends, for example, from about 0.4 km. to 2.0 km. A tandem regulator **115** (FIG. 5) actuated by the knob **15** controls the given flying time, i.e. the useful period available for steering the missile light speck **57**, in the program unit which is contained in the rack unit **24**, as well as the target size as a function of the set distance.

The adjusting knob **14** which acts on a potentiometer **114** (FIG. 5) controls the apparent speed of the target in that a voltage from the aforementioned target-distance regulator **15**, **115** and already influenced by the set target distance is tapped at the potentiometer **114** so that, for every distance setting of the target, the target light speck **58** moves across the screen of the cathode ray tube **4** at the correctly scaled speed. The speed of the speck **58** can be altered during a steering operation by means of the adjusting means **18** which adjusts a potentiometer **118**, **118***a* (FIG. 5) for each co-ordinate in the conventional manner. Similarly, the target size is set by means of the knob **14***a* (which acts on a potentiometer **114***a* (FIG. 5) in such a way that a correctly scaled representation of the set target diameter always appears on the screen.

The operating keys of the operating device **19** are designated start key **8**, ground key **9**, target key **10** and stop key **11**. By means of the start key **8**, the operation of the simulator can be commenced at any time and interrupted at any time by the stop key **11**. The ground key **9**, when not depressed, acts on the program unit **24** in a way such that, after setting the simulator into operation, target alignment (i.e. alignment of the light speck **57** simulating the missile with the speck **58** simulating the target) must be achieved within a predetermined period as calculated from the instant of depressing the start button **5** of the steering device **7** or the start key **8** of the operating device **19**. When the ground key **9** is depressed, however, the missile speck **57** can be steered by the device **7** without any time limit being imposed. At the same time the hereinafter described "automatic ground tuner" is in this case inoperative, i.e. the missile may fly over or under the target at will. In this case the missile speck **57** is steered so that its behaviour corresponds to a missile spaced at a constant distance of, say, 1000 m. from the person guiding it.

The target key **10** acts on the program unit **24** in such a way that, by means of the adjusting means **18**, the speed of the target speck **58** can be controlled when the key **10** is not depressed and its position can be controlled when the key is depressed.

The operating device **19** further comprises five signal lamps of which a lamp **23** (FIGS. 4 and 5) lights up when the device is switched on, even if only part of the device is alive. The remaining signal lamps **8***a*, **9***a*, **10***a*, **11***a* are located inside the keys **8**—**11** and light up according to which operating conditions of the simulator obtains at any one time.

The lamp **8***a* in the start key **8** lights up when the simulated missile is ready for firing and is extinguished after the missile has been fired. The lamp **9***a* in the ground key **9** lights up when the missile strikes the ground before reaching its target or when steering is interrupted, i.e. terminated, by actuating the stop key **11**. The lamp **9***a* goes out when the simulator is again ready for operation, i.e. when the lamp **8***a* in the key **8** relights. The signal lamp **10***a* in the target key **10** lights up when the target distance—predetermined flight period—as set in the timing mechanism of the program unit **24** has been reached by the simulated missile, regardless of whether the missile covers the target or flies over it. The lamp **11***a* in the stop key **11** lights up upon firing of the missile and goes out when it strikes the ground or the target.

In the rack unit **25** which serves as missile model, output voltages are set up which are a measure of the angular deviation from the line of sight. These output voltages are fed to the rack unit **27** which serves as a switching unit (also see FIG. 3). The missile model unit **25** essentially comprises four Miller integrator amplifiers—two for each co-ordinate—of the kind shown in FIG. 6, each containing the valves **45**, **46**, **47** and the resistances **201** to **209**.

After having set the starting conditions by actuating the adjusting means **16**, **17** at the operating device **19**, a voltage U*o* is fed through the resistance **210** to the amplifier shown in FIG. 6. By pressing the start button **5** or the start key **8**, the associated switches are moved into the FIG. 5 position and a throw-over switch **30** (FIG. 6) is actuated so that the control voltage U*st* (FIGS. 6 and 8) which can be set in the steering device **7**, now obtains at the resistance **210**. In the amplifier output, there is an operating switch **32** which is opened by the hereinafter described program unit **24** after the flight period has expired or when the flight is interrupted by "ground contact." In this way, the momentary voltage conditions are maintained by a capacitor C_1 (FIG. 6) for a few seconds—corresponding to the time constant of a capacitor C_2 in the program unit **24** (FIG. 8). The discharge current of the capacitor C_2 permits energisation of a relay R_2 actuating the operating switch **32**. The relay R_2 also operates the light modulation of the cathode beam at the instant the simulated missile strikes the ground or the target. The amplifier output is connected to the switching unit **27** (also see FIG. 3) through a cathode amplifier stage **34** comprising a valve **48** and a cathode resistance **211**.

The electric model of the target is accommodated in the rack unit **26** which simulates a target having the properties of a fixed vehicle or those of a mobile one, according to selection. The control of the target light speck **58** is carried out at the operating device by means of the adjusting means **18**, as described above. The rack unit **26** essentially comprises two Miller integrator-connected amplifiers of the kind shown in FIG. 6—one amplifier for each coordinate—and conventional apparatus for distending the target speck **58** to circular shape.

Also contained in the rack unit **26**, there is switching apparatus designated "automatic ground tuner" for simulating the ground below the flying missile. This apparatus also simulates the condition when the missile flies over the target, if that should be the case. The ouput voltages from the rack unit **26** (electric model of the target) are likewise fed to the switching means **27** (FIG. 3).

A differentiating amplifier as shown in FIG. 7 connected beyond the Miller integrator serves to represent ground contact by the missile. This amplifier comprises a double triode valve **49**. One grid E_1 of the valve **49** is supplied with a voltage Y_{Fk} determining the simulated missile height and the other grid E_2 at the commencement of the steering operation with a voltage Y_Z determining the simulated height of the lower target boundary. For determining the sign (plus or minus) of the difference between the voltages, representing the simulated missile and target heights, a three-coil polarised relay R_1 having two counter-connected coils is connected to the two anodes of the valve **49**. The third winding serves to introduce an auxiliary current J_B the behaviour of which when plotted on the time axis t represents the apparent approach to ground of a missile flying at eye-level some considerable distance away. After expiration of the set flight period t_v (FIG. 9) as simulated in the program unit **24**—i.e. when the target is apparently reached—the course of the auxiliary current J_B is varied so that it corresponds to gradually sloping terrain behind the target. At the same time, the voltage Y_Z associated with the target height is switched, through a switch **37** actuated by the program

unit 24, from a voltage value corresponding to the lower target boundary (as delivered by the target model 26 to the contact 50), to a voltage value corresponding to the upper target boundary (as delivered by the target model to the contact 51). After expiration of the steering program, i.e. upon commencement of the in-readiness condition for the next steering operation, the auxiliary current J_B is returned to its initial value Jo (FIG. 9) by the program unit 24. This current is chosen for size and polarity so that the polarized relay R_1 cannot be tripped over within the entire range of modulation of the differential amplifier (FIG. 7). The initial value Jo of the auxiliary current J_B thus prestresses the relay R_1 to such an extent that it cannot be switched over by the differential amplifier. The missile can only be steered within the cross-hatched portion in FIG. 9 by actuation of the control stick 6. As soon as the simulated missile touches the boundary of the cross-hatched region, the relay R_1 switches from the contact 52 to the contact 53, whereby the entire operation of the simulator is stopped, that is to say the timing mechanism in the program unit 24 and thus the computer in the rack unit 25 constituting the "missile model" and that in the rack unit 26 constituting the "target model" and thus the movements of the missile light speck 57 and of the target speck 58 are interrupted. In addition, the beam control at the cathode ray tube 4 is influenced through the relay R_2 (FIG. 8) so that discharge of the condenser C_2 causes short term brightening of the missile light speck 57. After about two seconds the program until 24 switches the auxiliary current J_B back to its starting value Jo and the switch 37 is switched over to the contact 50 so that the simulator is in readiness for commencing fresh operation.

Switching over of the relay R_1 can take place at any time by depressing the stop key 11 at the operating device 19 through the line 56 (FIG. 5), which likewise carries out the abovementioned switching operations.

If the simulated missile hits the simulated ground before striking the target and before expiration of the predetermined flight period, then the program unit 24 lights up the signal lamp 9a in the ground key 9 because, as already described, the relay R_1 closes the contact 53 even though the timing mechanism 36, presently to be described, in the program until 24 has not yet run out.

The above-described circuit constituting the "automatic ground tuner" can be made inoperative by actuating the ground key 9, the operating contact 53 of the polarized relay R_1 being switched off. Cutting out the ground tuner also makes the timing mechanism 36 in the program until 24 inoperative, so that the missile speck 57 simulates a missile flying at a constant spacing from the person guiding it.

As already described, the output of voltages from the missile model 25 and target model 26 are fed to the switching unit 27 which feeds these voltages alternately to the rack unit 28 serving as "deflection amplifier."

The deflection amplifier 28 is, for example, a transistorised two-channel push-pull amplifier and amplifies the output voltages from the switching unit 27 to a value required for deflecting the electron beam of the cathode ray tube 4.

The aforementioned program unit 24 co-ordinates and controls all those operations required to perform a steering operation. It comprises a generator 35 (FIG. 8) which, since it is fed by the condensers C_3 and C_4 and acts on the condensers C_5 and C_6, produces a voltage which is proportional to an exponential function $1/t$. In this way, the visual impression of a time decrease, as occasioned by perspective, in the apparent steerability of a real missile is simulated to scale. This voltage is fed to the steering device 7 where it can be regualed to the desired degree by adjusting the control column 6 for the purpose of steering the missile light speck. Further, there is provided a timing mechanism 36 in the form of a flip-flop stage and the valve 60, which mechanism determines the timing of the program, i.e. which substantially simulates the target distance which appears as the given flight period.

Further, relays R_3—R_{12} (FIG. 8) are provided which make or break the various line connections necessary for carrying out the described operations.

Three program phases are provided, namely, the preparatory stage up to releasing the missile light speck 57, the simulated flight of the missile with the actual steering step which terminates when the missile strikes the simulated ground or target, and the score control phase in which the momentary voltage conditions within the simulator are maintained for a short period.

When the automatic ground control is inoperative, the program unit 24 simulates a missile flying at a constant distance of, say, 1000 m. from the person guiding it and the controllability of which is constant. The generator 35 in this case receives a constant voltage through a potentiometer 33 and a switch 31 which had been switched over by a relay R_3 actuated by the ground key 9, so that at the generator output, i.e. the condensers C_5 and C_6, there is also a constant voltage. The steering device 7 is therefore supplied through the program unit 24 with a control voltage U_{sr} which is constant with time.

The missile velocity, i.e. the speed at which the missile speck 57 moves across the screen is adjustable at the program unit 24 by means of a potentiometer 38. Consequently, missiles of varying transverse speeds can be simulated.

As already mentioned, an operation is commenced by means of the start button 5 in the steering device 7 or the start key 8 in the operating device 19. This causes a relay R_4 to be energised which actuates the operation of the program unit 24. The timing mechanism 36, which determines the duration of the operating step, i.e. the flight period of the simulated missile, when the automatic ground tuner is switched on, receives its time defining voltage through the tandem regulator 115 (FIG. 5) in the operating device 19. This voltage charges a condenser C_7. Upon depressing the start button 5 or start key 8, the relay R_4 switches a switch 39 so that the condenser C_7 can discharge through the line 61 and thereby determine the switching time of the valve 60.

Finally, there is provided a calibrating unit 29 (FIG. 2), essentially comprising four selector switches 44, namely, one each for the rack units of the missile model 25, the target model 26, switching unit 27 and the deflecting amplifier unit 28. With the aid of these selector switches 44, the signal voltages from and to the rack units can be controlled, switched over, and replaced by measuring voltages. The voltages at the selector switches 44 are co-ordinated with the calibrating regulators 66 (FIG. 6), 67 to 70 (FIG. 5)—potentiometers—provided at the various structural groups, so that the entire simulator can be adjusted, the positions of the missile light speck 57 and the target speck 58 on the screen of the tube 4 being used as indications and criteria for the calibrating steps.

We claim:

1. In a guided missile simulator of the kind described, a housing containing a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said deflection amplifier, a first electronic unit connected to said switching unit, a second electronic unit connected to said switching unit and a program unit connected to said first and second units, steering means adapted to be installed apart from the housing, a control element in the form of a control column on said steering means, operating means adapted to be installed apart from the housing, control and switch elements on said operating means, a first electric cable electrically connecting said steering means to said first unit and to said program unit, and a second electric cable electrically connecting said operating means to said second unit and to said program unit.

2. In a guided missiles simulator of the kind described,

a cathode ray tube comprising electron beam deflection means and a screen, steering means, a manually-operable control element on said steering means, an electronic unit effective to simulate the movements of a missile, said electronic unit being electrically connected to said steering means, said steering means being effective to apply control voltages to said electronic unit as governed by manipulations of said control element, said electronic unit being effective to modify said control voltages and act on said deflection means whereby a missile-simulating light spot is caused to traverse said screen, indicating means, voltage comparison means connected to said indicating means, a discriminator stage connected to said comparison means, said electronic unit being effective to form a first comparison voltage proportional to the instantaneous height of the simulated missile on said screen and a second comparison voltage proportional to the height of a simulated target, said comparison means being effective to form a difference between said first and second comparison voltages and feed a current corresponding to said voltage difference to said discriminator stage, said discriminator stage being effective to compare said corresponding current with a current which varies according to a given function and to actuate said indicating means when said corresponding current and said varying current are in a given relationship to one another.

3. In a guided missiles simulator of the kind described, a cathode ray tube comprising electron beam deflection means and a screen, steering means, a manually-operable control element on said steering means, an electronic unit effective to simulate the movements of a missile, said electronic unit being electrically connected to said steering means, said steering means being effective to apply control voltages to said electronic unit as governed by manipulations of said control element, said electronic unit being effective to modify said control voltages and act on said deflection means whereby a missile-simulating light spot is caused to traverse said screen, brightness control means for said cathode ray tube, voltage control means connected to said brightness control means, comparison means, a discriminator stage connected to said comparison means, said electronic unit being effective to form a first comparison voltage proportional to the instantaneous height of the simulated missile on said screen and a second comparison voltage proportional to the height of an assumed target, said comparison means being effective to form a difference between said first and second comparison voltages and feed a current corresponding to said voltage difference to said discriminator stage, said discriminator stage being effective to compare said corresponding current with a current which varies according to a given function and to actuate said brightness control means through a switch when said corresponding current and said varying current are in a given relationship to one another.

4. In a guided missiles simulator of the kind described, a cathode ray tube comprising electron beam deflection means and a screen, steering means, a manually-operable control element on said steering means, an electronic unit effective to simulate the movements of a missile, said electronic unit being electrically connected to said steering means, said steering means being effective to apply control voltages to said electronic unit as governed by manipulations of said control element, said electronic unit being effective to modify said control voltages and act on said deflection means whereby a missile-simulating light spot is caused to traverse said screen, indicating means, a double triode valve, said electronic unit being effective to apply to one grid of said triode valve a first comparison voltage proportional to the instantaneous height of the simulated missile on said screen, and to the second grid of said triode valve a second comparison voltage proportional to the height of an assumed target, a discriminator stage connected to the anodes of said triode valve, said discriminator stage being effective to compare the sum of the anode currents with a current which varies according to a given function and to actuate said indicating means when a given comparison value obtains.

5. A guided missile simulator comprising a single-beam cathode ray tube fitted with deflection means and a screen for said beam, a first electronic unit for simulating the movements of a missile, a second electronic unit for simulating a target, an electronic switching unit adapted to connect said first unit and said second unit alternately and rapidly to said deflection means, whereby a light spot visually simulating said missile and a light spot visually simulating said target are caused to appear simultaneously on said screen, a manually-operable program unit effective to carry out a timing program and to produce a control voltage which steadily decreases in value from the moment of operation of said program unit for a set period, steering means electrically connected to said first unit and to said program unit, a manually-operable control element on said steering means, said steering means being adapted to apply to said first unit and to modify the said steadily decreasing control voltage from the program unit as governed by manipulations of said control element, whereby said first unit and said deflection means are effective to cause the simulated missile to move across said screen in the same manner as a perspective projection of a real guided missile would move, brightness control means for said cathode ray tube, a discriminator stage connected to said brightness control means, said program unit being effective to feed said discriminator stage a current which increases in value from the moment of operation of said program unit, said first unit being effective to feed to said discriminator stage a current proportional to the height of the simulated missile on the screen and said second unit being effective to feed said discriminator stage a current proportional to the height of the simulated target, said discriminator stage being effective to actuate said brightness control means when the sum of the currents compared passes through zero.

6. A guided missiles simulator comprising a single-beam cathode ray tube fitted with deflection means and a screen for said beam, a first electronic unit for simulating the movements of a missile, a second electronic unit for simulating a target, an electronic switching unit adapted to connect said first unit and said second unit alternately and rapidly to said deflection means, whereby a light spot visually simulating said missile and a light spot visually simulating said target are caused to appear simultaneously on said screen, steering means electrically connected to said first unit, a manually-operable control element on said steering means, said steering means being adapted to apply control voltages to said first unit as governed by manipulations of said control element, said first unit being adapted to modify said control voltages whereby said deflection means are effective to cause the simulated missile to move across said screen in the same manner as a perspective projection of a real guided missile would move, operating means electrically connected to said second unit, a manually-operable control element on said operating means, said operating means being adapted to apply control voltages to said second unit, said second unit being adapted to modify the control voltages applied to said second unit, whereby said deflection means are effective to cause the simulated target to move across said screen in conformity with the characteristics of a mobile real target, brightness control means for said cathode ray tube, a discriminator stage connected to said brightness control means, a program unit, said program unit being arranged to feed to said discriminator stage a current which increases in value from the moment of operation of said program unit, said first unit being effective to feed to said discriminator stage a current proportional to the height of the simulated missile on the screen and said second unit being effective to feed to said discriminator stage a current proportional to the height of the simulated target, said discriminator stage being effective

to actuate said brightness control means when the sum of the currents compared passes through zero.

7. The simulator of claim 6, wherein said increasing current from the program unit has a time characteristic comprising two arcuate paths and a point of sudden discontinuity therebetween, said second unit being effective to control the time position of said discontinuity in accordance with the distance of the target and to control the height of said discontinuity in accordance with the apparent absolute size of the target, whereby the current from the program unit prevents apparent underflying of the target, and, upon overflying of the target, subsequent redirecting of the simulated missile is avoided regardless of to where the target has been moved.

8. The simulator of claim 6, wherein said operating means comprise manually-operable switch means, said switch means being effective to render said discriminator stage inoperative.

9. In a guided missiles simulator of the kind described, a housing containing a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said deflection amplifier, a first electronic unit connected to said switching unit, a second electronic unit connected to said switching unit and a program unit connected to said first and second units, steering means adapted to be installed apart from the housing, a control element in the form of a control column on said steering means, operating means adapted to be installed apart from the housing, switching elements and a control element on said operating means effective to set the apparent target distance, said steering means being electrically connected by cable to said first unit and to said program unit, said operating means electrically connected by cable to said second unit and to said program unit, said control element being connected to said program unit and determining the duration of an operation therein.

10. In a guided missiles simulator of the kind described, a housing containing a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said deflection amplifier, a first electronic unit connected to said switching unit, a second electronic unit connected to said switching unit, a program unit connected to said first and second units, steering means adapted to be installed apart from the housing and connected thereto by cable, a control element in the form of a control column on said steering means, operating means adapted to be installed apart from said housing and connected thereto by cable, switching means on said operating means, control means on said operating means in the form of a control column, said control column being connected to said first unit and being effective to apply control voltages thereto which simulate the apparent starting conditions of the missile, namely, the starting place and starting direction of the simulated missile on the screen of the cathode ray tube.

11. In a guided missiles simulator of the kind described, a housing, a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said deflection amplifier, a first electronic unit connected to said switching unit, a second electronic unit connected to said switching unit, a program unit connected to said first and second units, steering means adapted to be installed apart from the housing, means connecting said steering means to said first electronic unit, a control column on said steering means, operating means adapted to be installed apart from said housing and connected thereto by cable, means connecting said operating means to said second electronic unit, switching means on said operating means including a plurality of switch elements, a control column on said operating means, said control column being arranged to determine via said second unit the direction of movement of a target simulating light spot on the screen of the cathode ray tube, and means whereby, depending on actuation of one of said switch elements, said direction of motion is unalterable after actuating the program unit or is variable at will at all times.

12. In a guided missiles simulator of the kind described, a housing containing a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said amplifier, a first electronic unit connected to said switching unit, a second electronic unit connected to said switching unit, whereby a given geometric figure simulating the target is caused to appear on the screen of said cathode ray tube, a program unit connected to said first and second units, a steering means adapted to be installed apart from the housing and connected to said first unit and to said program unit by cable, a control column on said steering means, operating means adapted to be installed apart from said housing and connected to said second unit and said program unit by cable, switching means and control means on said operating means, said switching and operating means being effective to set the size and speed of the simulated target on said screen.

13. In a guided missiles simulator of the kind described, a housing containing a single-beam cathode ray tube, a deflection amplifier effective to control said cathode ray tube, an electronic switching unit connected to said deflection amplifier, a first electronic unit connected to said electronic switching unit, a second electronic unit connected to said switching unit, a program unit connected to said first and second units, a timing mechanism in said program unit, said timing mechanism being effective to determine the terminating period of an operation by said program unit after said program unit has been actuated, steering means adapted to be installed apart from said housing and connected to said first unit and to said program unit by cable, a control column on said steering means, operating means adapted to be installed apart from said housing and connected to said second unit and to said program unit by cable, several control means and push keys for actuating said program unit, for resetting the simulated target and the simulated missile on said screen to a starting position and for rendering the timing mechanism in the program unit inoperative.

14. A missile and target simulator for training marksmen to steer guided missiles onto a mobile target, including a single-beam cathode ray tube having a screen and including means to deflect the beam in two perpendicular coordinate directions in the plane of the screen of the tube, a target computer, a missile computer, and means connected to the beam deflecting means and to the computers to switch the target computer and the missile computer rapidly and alternately to the beam deflection means to control the positions of the two light traces on the screen simulating the target and the missile, a target steering device connected to the target computer and being constructed and arranged to apply control voltages to vary the position of the target light trace in correspondence with the movements of the target steering device, a missile steering device connected to the missile computer and being constructed and arranged to apply control voltages to vary the position of the missile light trace in correspondence with movements of the missile steering device, and a program unit connected to the missile computer and being constructed and arranged to reduce the output voltages of the computer in dependence upon the time interval which elapses from the moment of switching in the computers to simulate the passage of the missile from the marksmen towards the target, the program unit being constructed and arranged to switch off the missile computer after a preset time interval.

15. A missile and target simulator for training marksmen to steer guided missiles onto a mobile target by means of a steering device, comprising a single-beam cathode ray tube, fitted with a screen for said beam, with an x-deflection system for deflecting the beam in the direction of an x-coordinate and fitted with a y-deflection system for deflecting the beam in the direction of a y-coordinate, said x-coordinate and said y-coordinate being in

a plane perpendicular to the line of sight to the simulated target, an x-missile computer having at least one integration unit and being adapted to simulate the movements of a missile in the direction of said x-coordinate, a y-missile computer having at least one integration unit and being adapted to simulate the movements of the missile in the direction of said y-coordinate, an x-target computer having at least one integration unit and being adapted to simulate the movements of a target in the direction of said x-coordinate, a y-computer having at least one integration unit and being adapted to simulate the movements of said target in the direction of said y-coordinate, a missile steering device having a manually-operable missile control element and being adapted to apply control voltages to said x- and y-missile computers, the magnitudes of said voltages depending on the amount of displacement of the control element from a neutral position, a target steering device having a manually-operable target control element and being adapted to apply control voltages to said x and y target computers, the magnitudes of said voltages depending on the amount of displacement of said target control element from a neutral position, a program unit constructed and arranged to apply a control voltage to the x- and y-missile computers, which voltage reduces the output voltages of the computers in dependence on the time interval running from the moment of switching in the computers to simulate the distance of the missile from the marksman, which distance increases proportionally to the time interval, means in the program unit to switch off the computers after a time interval corresponding to the flying time of the missile to the target, and an electronic switching unit constructed and arranged to connect said outputs of the x and y-missile computers and of the x and y-target computers alternately and rapidly to said x and y deflection systems respectively, whereby a light spot visually simulating said missile and a light spot visually simulating said target are caused to appear simultaneously on said screen.

16. A missile and target simulator for training marksmen to steer guided missiles onto a mobile target by means of a steering device, comprising a single-beam cathode ray tube fitted with a screen for said beam, with an x-deflection system for deflecting the beam in the direction of an x-coordinate and fitted with a y-deflection system for deflecting the beam in the direction of a y-coordinate, said x-coordinate and said y-coordinate being in a plane perpendicular to the line of sight to the simulated target, an x-missile computer having at least one integration unit and being adapted to simulate the movements of a missile in the direction of said x-coordinate, a y-missile computer having at least one integration unit and being adapted to simulate the movements of the missile in the direction of said y-coordinate, an x-target computer having at least one integration unit and being adapted to simulate the movements of a target in the direction of said x-coordinate, a y-target computer having at least one integration unit and being adapted to simulate the movement of said target in the direction of said y-coordinate, a missile steering device which is disposable in front of the screen of the cathode ray tube, so that the marksman operating the missile control element can observe said screen, and having a manually operable missile control element, said steering device being constructed and arranged to apply control voltages to said x and y-missile computers, the magnitudes of said voltages depending on the amount of displacement of the control element from a neutral position, a target steering device having a manually operable control element and being constructed and arranged to apply control voltages to said x and y target computers, the magnitudes of said voltages depending on the amount of displacement of said target control element from a neutral position, a program unit constructed and arranged to apply a control voltage to the x and y missile computers, which voltage reduces the output voltages of the computers in dependence on the time interval running from the moment of switching in the computers to simulate the distance of the missile from the marksman, which distance increases proportionally to the time interval, means in the program unit to switch off the computers after a time interval corresponding to the flying time of the missile to the target, and an electronic switching unit constructed and arranged to connect said outputs of the x and y missile computers and of the x and y target computers alternately and rapidly to the x and y deflection systems respectively of the cathode ray tube, whereby a light spot visually simulating said missile and a light spot visually simulating said target are caused to apper simultaneously on said screen.

17. The simulator of claim 15, including voltage comparison means, means in said program unit to apply to said comparison means a voltage which steadily increases in value from the moment of switching in said program unit for the purpose of simulating terrain sloping towards the target, means in said y-missile computer to apply to said comparison means a voltage proportional to the height of the simulated missile on said screen, means in said y-target computer to apply to said comparison means a voltage proportional to the height of the simulated target, a switch electrically connected to said comparison means, and means operated by said comparison means to actuate said switch when the simulated missile strikes the simulated sloping terrain.

18. The simulator of claim 17, wherein said switch is electrically connected to said program unit and, when actuated by said comparison means, is constructed and arranged to render said program unit inactive and return it to a starting condition preparatory to performance of a subsequent timing program.

19. The simulator of claim 17, including score-control switching means electrically connected to said switch and constructed and arranged, when said switch is actuated, to hold the simulated missile and the simulated target in their respective momentary positions.

20. The simulator of claim 17, including beam modulation means connected to said cathode ray tube, a capacitor connected in said program unit to be charged thereby, and means including said switch to connect said capacitor to said beam modulation means whereby, upon actuation of said switch, the simulated missile is caused to brighten up by brightness control of said cathode ray tube.

21. A missile and target simulator for training marksmen to steer guided missiles onto a mobile target by means of a steering device, comprising a single-beam cathode ray tube fitted with a screen for said beam, with an x-deflection system for deflecting the beam in the direction of an x-coordinate and fitted with a y-deflection system for deflecting the beam in the direction of a y-coordinate, said x-coordinate and said y-coordinate being in a plane perpendicular to the line of sight to the simulated target, an x-missile computer having at least one integration unit and being adapted to simulate the movements of a missile in the direction of said x-coordinate, a y-missile computer having at least one integration unit and being adapted to simulate the movements of the missile in the direction of said y-coordinate, an x-target computer having at least one integration unit and being adapted to simulate the movements of a target in the direction of said x-coordinate, a y-target computer having at least one integration unit and being adapted to simulate the movements of said target in the direction of said y-coordinate, a missile steering device having a manually operable missile control element and adjustable x and y-resistances, the resistance values of which vary with the amount of displacement of the control element out of a neutral position in a x- or y-direction respectively, said x- and y-resistances being connected to the x- and y-computers respectively, a target steering device having a manually operable target control element and being constructed and arranged to apply control voltages to said x and y target computers, a program

unit constructed and arranged to apply a control voltage to said x and y resistances, which voltage decreases from the moment of switching in the computers to simulate the distance of the missile from the marksman, which distance increases proportionally to the time interval from said moment, means in said program unit to switch off the computers after a time interval corresponding to the flying time of the missile to the target, and an electronic switching unit constructed and arranged to connect said outputs of the x and y missile computers and of the x and y-target computers alternately and rapidly to said x and y deflection systems, whereby a light spot visually simulating said missile and a light spot visually simulating said target are caused to appear simultaneously on said screen.

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